M.R.P. 1045
S.C. 11/233
28th March, 1957

Average height of the standard isobaric surfaces over the temperate and tropical regions in January

by

H. Heastie

(Meteorological Office)

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METEOROLOGICAL RESEARCH COMMITTEE

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1. Introduction

This paper is a further step in the revision of Geophysical Memoir 85 - Upper Winds over the World. In three earlier papers (1, 2, 3), the contours of the standard isobaric surfaces were mapped over an area from the North Pole to 55° N. for the four mid-season months January, April, July and October and this paper extends the mapping, for the month of January, down to 60°S. on a Mercator projection. It was not considered feasible to extend the charts any further south owing to the extreme scarcity of upper air data from Antarctica.

2. The data

Data for the same period 1949-53 were used. The main sources were manuscript data, the Climat Temp reports and the tabulations in U.S.W.B. Daily Series Synoptic Weather Maps, together with daily, monthly and annual publications of various countries. Further details are given in the appendix. The daily synoptic charts from Central Forecasting Office, Dunstable were used to supplement data in the Atlantic, European and North African regions of the chart. At some stations the hour of the observation varied during the period and the hour was not the same at all stations. Whenever available, data from ascents made in darkness were used in order to minimise errors due to solar radiation. As, further, the type of instrument varied from station to station, no attempt was made to apply radiation corrections systematically. An exception was made over stations in South Africa where a Canadian type of instrument was in use and corrections for radiation were made based on a paper by Henry (4) comparing the Canadian and American types of radiosonde. For Nairobi, Aden, Bahrein and Hong Kong a correction was made to the 100 mb temperature. For most of the period, at these stations the correction curves for the effect of temperature on the pressure element of the radiosonde were incorrectly extrapolated for temperatures below -90°F and, in consequence, the temperature reading at 100 mb was from 1°C to 3°C too high. Wind data, which were readily available for British overseas stations and Hong Kong, were used. The period of these data was 1948-53 in general, though shorter periods only were available for some stations.

3. Method of constructing the charts

(1) General. In constructing the circumpolar charts it was found necessary to draw a separate set of charts for each year. This necessity arose from the great variability of the pattern from year to year together with the fact that data from few stations were available with equal reliability for all five years. The drawing of five sets of charts naturally delays the production of of the average charts and an attempt was made to draw the average circumpolar charts for one month (July) directly from the data meaned over the five years. From this test it was decided that the drawing of yearly circumpolar charts was justified but that this procedure might not be necessary for the Mercator charts. A large part of the region between 55°N. and 60°S. lies in the

/tropics

tropics and subtropics where the changes in contour height from year to year are comparatively small. In the zones from 55°N. to 30°N. and from 30°S. to 60°S. such data as there are are fairly complete for the whole five years. In consequence it has proved unnecessary to draw charts for each year and the charts submitted in this paper were drawn from data meaned over the five year period.

(2) 700 mb chart. Where available the data were fairly complete and mean values were acceptable. There were however large areas with no available data. To obtain a pattern over these areas grid values of 700 mb contour height were evaluated as follows. A chart of M.S.L. pressure in the southern hemisphere was constructed using grid values of mean pressure for the period 1949-53 (5). This chart was extended to about 20°N. with the aid of a chart of average M.S.L. pressure obtained from the World Climatology Branch of the Meteorological Office. From this chart and values of M.S.L. temperature supplied by the Marine Division of the Meteorological Office, grid values of 1,000 mb contour height were evaluated. These were added to values of 1,000-700 mb thickness evaluated from M.S.L. temperature and 700 mb temperature read off the average temperature chart in the memoir on upper air temperature (6) to obtain grid values of 700 mb contour height, a correction for humidity being first applied to the thickness values. A 700 mb contour chart was sketched from these grid values; the final 700 mb contour chart was then drawn, primarily from the actual data, but using the sketched map as a guide.

(3) 500 mb and 300 mb charts. A map of 700-500 mb thickness was sketched from grid values derived from the charts of average 700 mb and 500 mb temperature in the memoir (6). The 700-500 mb thickness chart was then drawn from the data with the aid of the sketched map. Grid values of 500 mb height were evaluated by adding 700 mb contour to 700-500 mb thickness values and the 500 mb contour chart drawn from the data with the aid of these grid values. Minor adjustments were then made between the three charts to make them consistent. The 500-300 mb thickness and the 300 mb contour charts were then drawn in a similar manner.

(4) 200 mb, 150 mb and 100 mb charts. Above 300 mb the data from an increasing number of stations became more and more unreliable owing to a loss of observations with height. Charts of 300 mb temperature and of lapse of temperature from 300 to 200 mb were therefore drawn, primarily from the data, but with the aid of the average temperature charts in the memoir (6). From these two charts a chart of 200 mb temperature was drawn. Some adjustment was then made to the three charts to remove minor irregularities arising from the gridding technique. The charts of 300 mb and 200 mb temperature were then used in conjunction with the charts of average temperature and pressure at the tropopause (6) to evaluate grid values of "correction for tropopause" (1) for the lower tropopause in the relevant areas of both hemispheres. Values so obtained for the southern hemisphere did not lead to a reasonable pattern and a new set was evaluated based on analogy with the values in the northern hemisphere and on values obtained from Australian and New Zealand data. Grid values of 300-200 mb thickness were then evaluated from values of 300 mb and 200 mb temperature and of "correction for tropopause". The 300-200 mb thickness chart was drawn from the data and with the assistance of these grid values. Finally, to remove minor irregularities, slight adjustments were made between the charts of 300 mb and 200 mb temperature, the chart of temperature lapse from 300 to 200 mb and the 300-200 mb thickness chart. Values of 300-200 mb thickness were then added to those of 300 mb contour height to obtain values of 200 mb contour height and the 200 mb contour chart was drawn from the data and these grid values. The charts of 200-150 mb and 150-100 mb thickness and of 150 mb and 100 mb contour height were drawn in a similar manner, though without the complication of a "correction for tropopause". The upper tropopause is generally above the 100 mb surface, but does fall to 115-120 mb over Tasmania and New Zealand, and perhaps elsewhere, though data are lacking. However, no correction on account of the upper tropopause was made because a check, using values from the New Zealand data, suggested that the requisite correction was probably less than 10 metres everywhere. The 100 mb chart showed some irregularities and these were removed by making minor adjustments to the charts as a whole. Finally a few minor amendments were made along the 55°N. parallel to improve the fit between the circumpolar and Mercator charts.

4. The charts

It should be noted that, on the contour charts, the isopleth interval is 100 geopotential metres while, on the thickness charts, the interval is 50 geopotential metres. North of 55°N. the charts are merely the redrawing of the circumpolar charts on the Mercator projection apart from some very minor amendments along the 55°N. parallel.

In the tropics the contours bear little relation to the actual flow, but in extratropical regions a mainly westerly flow is shown in both hemispheres, with much greater meridional components in the northern hemisphere. There the main troughs occur at 80°W. and 140°E. in association with the cold lows over northern Canada and Siberia. The main ridges are at 160°W. and 0°W. with a weak trough-ridge pattern over eastern Europe and Russia. The axis of the ridge at 0°W. is more tilted in a SSW.-NNE. direction than are the other features and there is a pronounced trough over the western Sahara. In the southern hemisphere troughs and ridges are much less pronounced. The main trough appears to be at about 40°E. with a subsidiary trough at 40°W. though in the lower layers there is a more pronounced trough in subtropical latitudes at 180°E. The troughs at 40°E. and 40°W. reflect the surface pattern (5) and there is some suggestion that both may form part of a wave train set up by the Andes.

Average contour charts tend to smooth out the jet streams which appear on the daily charts, but at 300 mb two strong wind belts can be noted over the North Atlantic. These are associated with the polar and subtropical jet streams. The more southerly one can be seen to link up across the Sahara with the strong wind belt of the Middle East which in turn extends across India to form part of the very strong belt over and south of Japan. The more northerly one becomes diffuse towards Europe and it is not possible to identify two separate streams elsewhere on the chart. These features are also distinguishable on the 200, 150 and 100 mb charts. In the southern hemisphere the data are too sparse to provide much detail. The strongest wind belt appears to lie between 45° and 50°S., though there is some suggestion that in the sector south of Africa it swings north to about 40° to 45°S. In the Australia - New Zealand sector there is a further wind maximum at 30° to 35°S. on the 200 mb and 150 mb contour charts. Hutchings (7) has drawn a southern hemisphere cross-section along the 170°E. meridian which shows wind maxima, at about 200 mb, of 60 kt. at 47°S. and 50 kt. at 32°S. The present charts show wind maxima at the same latitudes, but with the stronger wind at the lower latitude. Another cross-section along the 150°E. meridian has been drawn by Gibbs (8), who shows two wind maxima, one of 50 kt. at 200 mb at 32°S. and the second of 40 kt. at 320 mb at 62°S. The first agrees very well with the present charts, which, however, show the second maximum at 200 mb and at about 47°S. It is, of course, possible to make only a rough comparison without drawing actual cross-sections from the charts.

References

(1) Heastie, H. Average height of the standard isobaric surfaces over the area from the North Pole to 55°N. in January. Meteorological Research Papers, Air Ministry, London, No. 918, 1955.

(2) Heastie, H. Average height of the standard isobaric surfaces over the area from the North Pole to 55°N. in July. Meteorological Research Papers, Air Ministry, London, No. 981, 1956.

(3) Heastie, H. Average height of the standard isobaric surfaces over the area from the North Pole to 55°N. in April and October. Meteorological Research Papers, Air Ministry, London, No. 1020, 1957.

(4) Henry, T. J. G. A comparison of mean temperatures obtained with Canadian and American types of radiosonde. Department of Transport, Meteorological Division, Toronto, Circular 2041, 1951.

(5) Pretoria, South African Weather Bureau. Notos, Vol. 4, No. 1, 1955.

(6) Goldie, N., Moore, J. G. and Austin, E. E. Upper air temperatures over the world. Geophys. Mem. No. 101, London (in the press).

(7) Hutchings, J. W. A meridional atmospheric cross-section for an oceanic region. J. Met., Vol. 7, p. 94.

(8) Gibbs, W. J. A comparison of hemispheric circulations with particular reference to the western Pacific. Quart. J. R. Met. Soc., 79, p. 121, 1953.

Appendix

1. Climat Temp data were used where available and the countries for which various sources of data, other than Climat, were used are listed below.

(a) Manuscript data

Australia
British East Africa
Canada
Ceylon
Eire
Falkland Islands
Germany (British Zone)
Hong Kong
New Zealand
Nigeria
Portuguese East Africa
Sudan
Thailand
United Kingdom (including overseas stations)
Weather ships

(b) Micro-film

Pacific Islands
Panama
Philippines
Weather ships

(c) Data tabulations from U.S.W.B. Daily Series Synoptic Weather Maps

Austria
Azores
Bermuda
Czechoslovakia
France
French North Africa
French Sahara
Greece
Italy
Mexico
Nicaragua
Pacific Islands
Philippines
Poland
Roumania
Turkey
U.S.S.R.
West Indies
Whoelus Field

(d) Daily weather reports

Czechoslovakia
Egypt
Germany
Greece
Holland
India
Portugal (including islands)

(f) Monthly publications

Belgian Congo
Belgium
Cocos Island
French Equatorial Africa
India
Indo-China
Japan, Japanese Islands and Weather ships
Korea
Madagascar and Amsterdam Island
Mexico
Spain
United States of America and American Pacific Islands
West Indies

(g) Annual reports

Angola
Holland
Hong Kong
Hungary
Switzerland
Union of South Africa
Venezuela

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2. Special publications

Presentation of meteorological data for the North American sector for the year 1949. Final Report, Vol. II. Johns Hopkins University, Baltimore

Weather ships N and P

Australian National Antarctic Research Expedition. Series D, Meteorology

Heard Island
Macquarie Island

Les Observations Météorologiques de Port-Martin en Terre Adélie, Fasc. III

Adélie Land

Aerological Data for Southern Canada

Canada

This list refers to data for stations south of 55°N.

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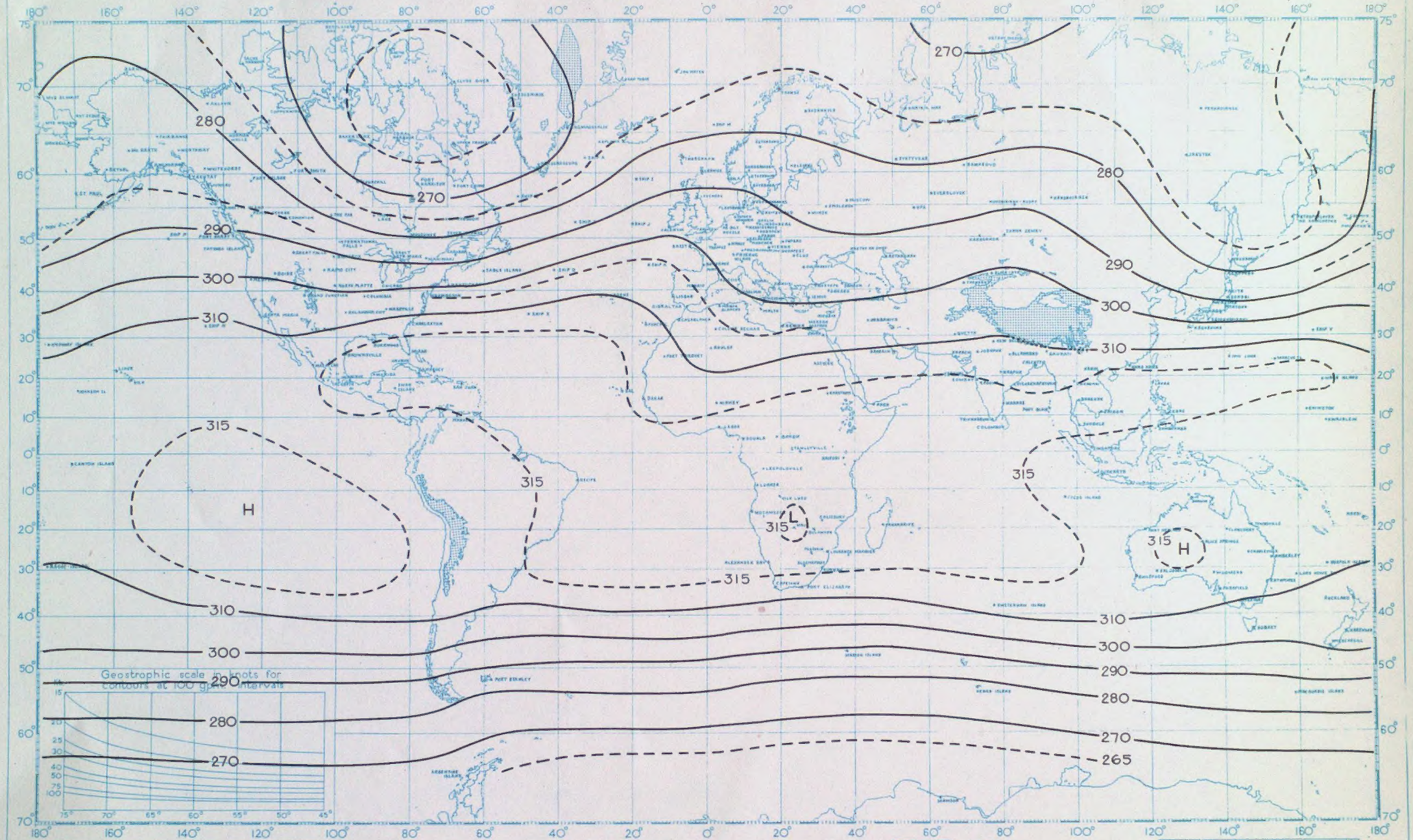
Average 700 mb. Contours

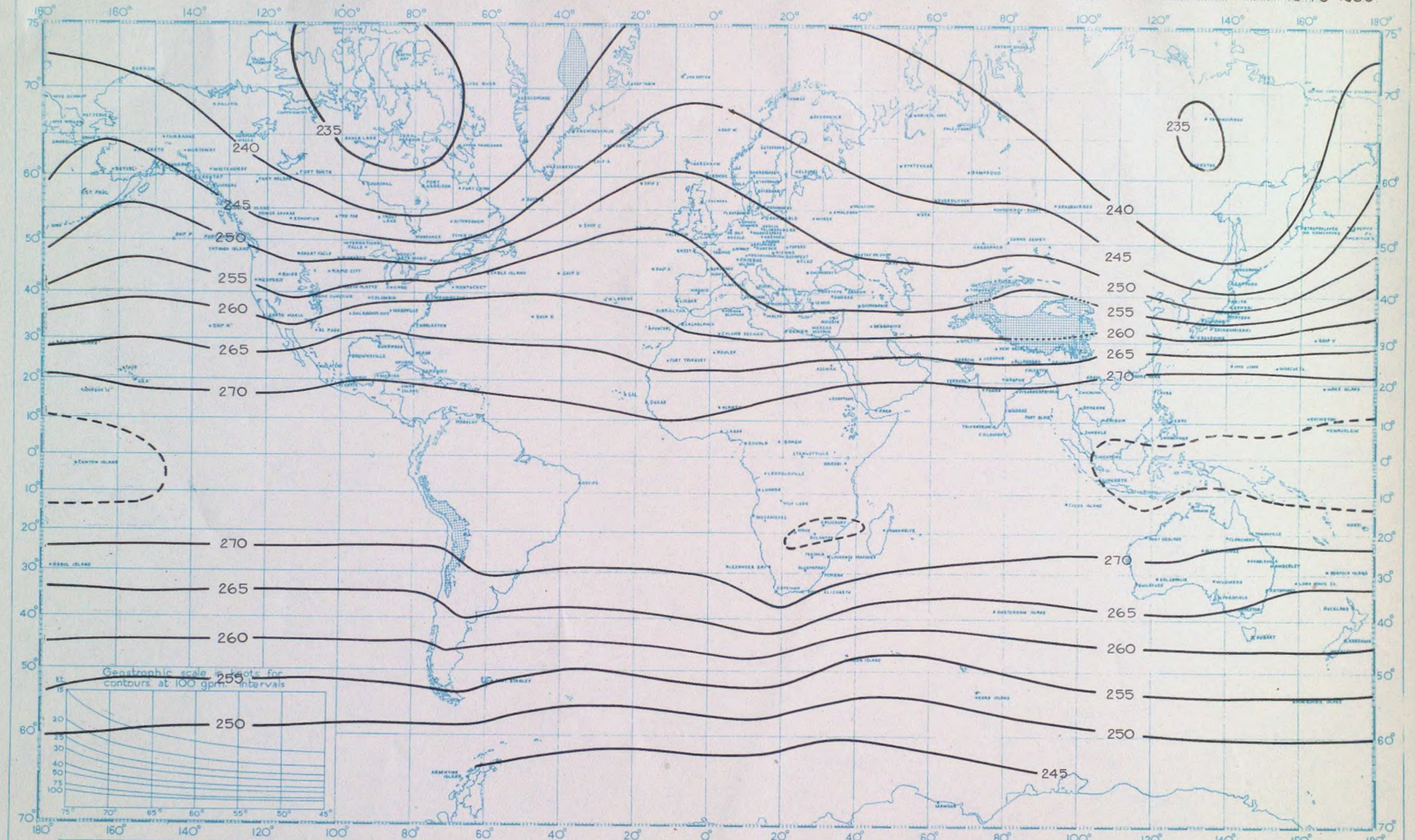
JANUARY 1949-1953



M.R.P. 1045

Average 700–500 mb. Thickness

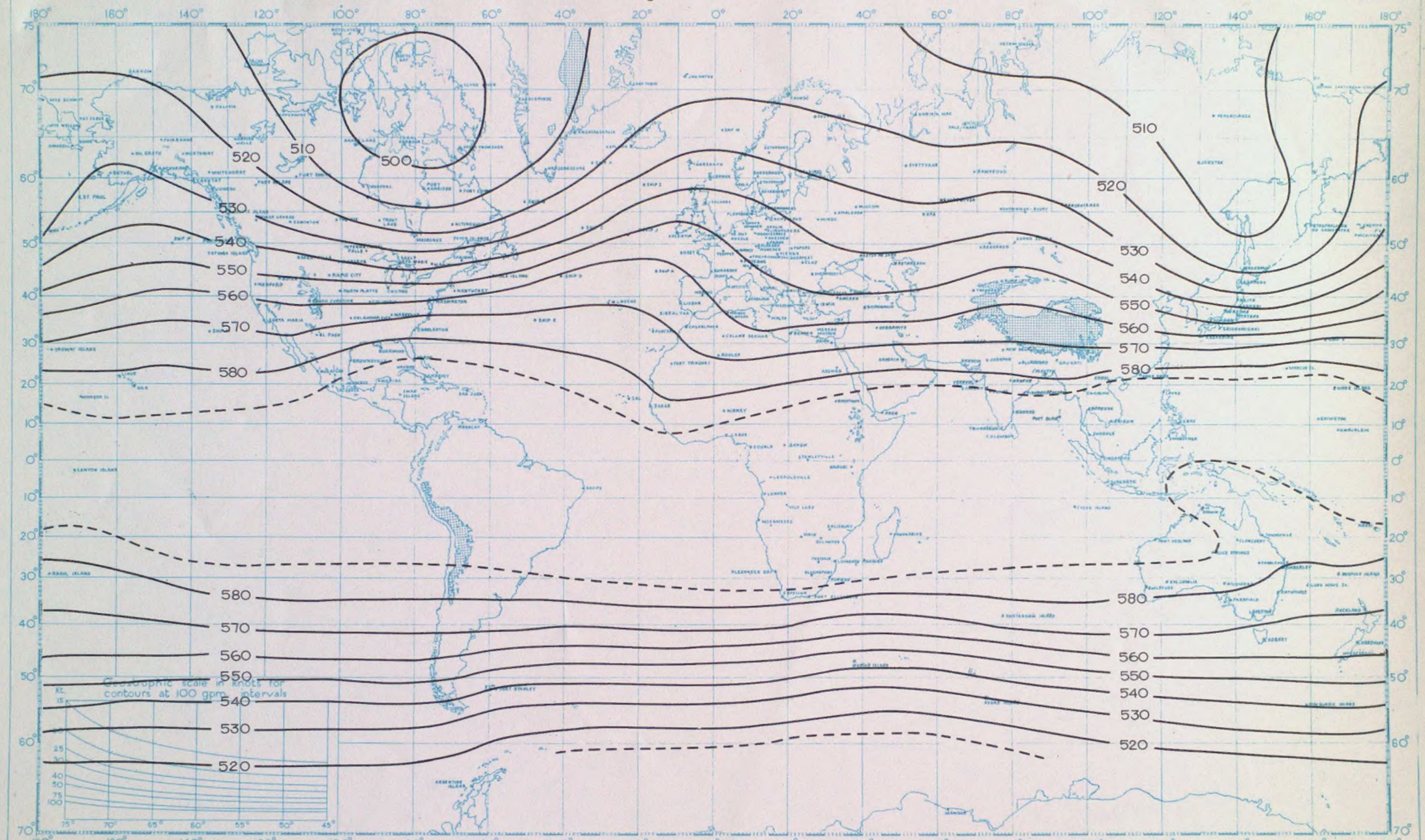
JANUARY 1949-1953



M.R.P. 1045

Average 500 mb. Contours

JANUARY 1949–1953



Temperature in °C.

Height in dekametres

Revised to May 1955

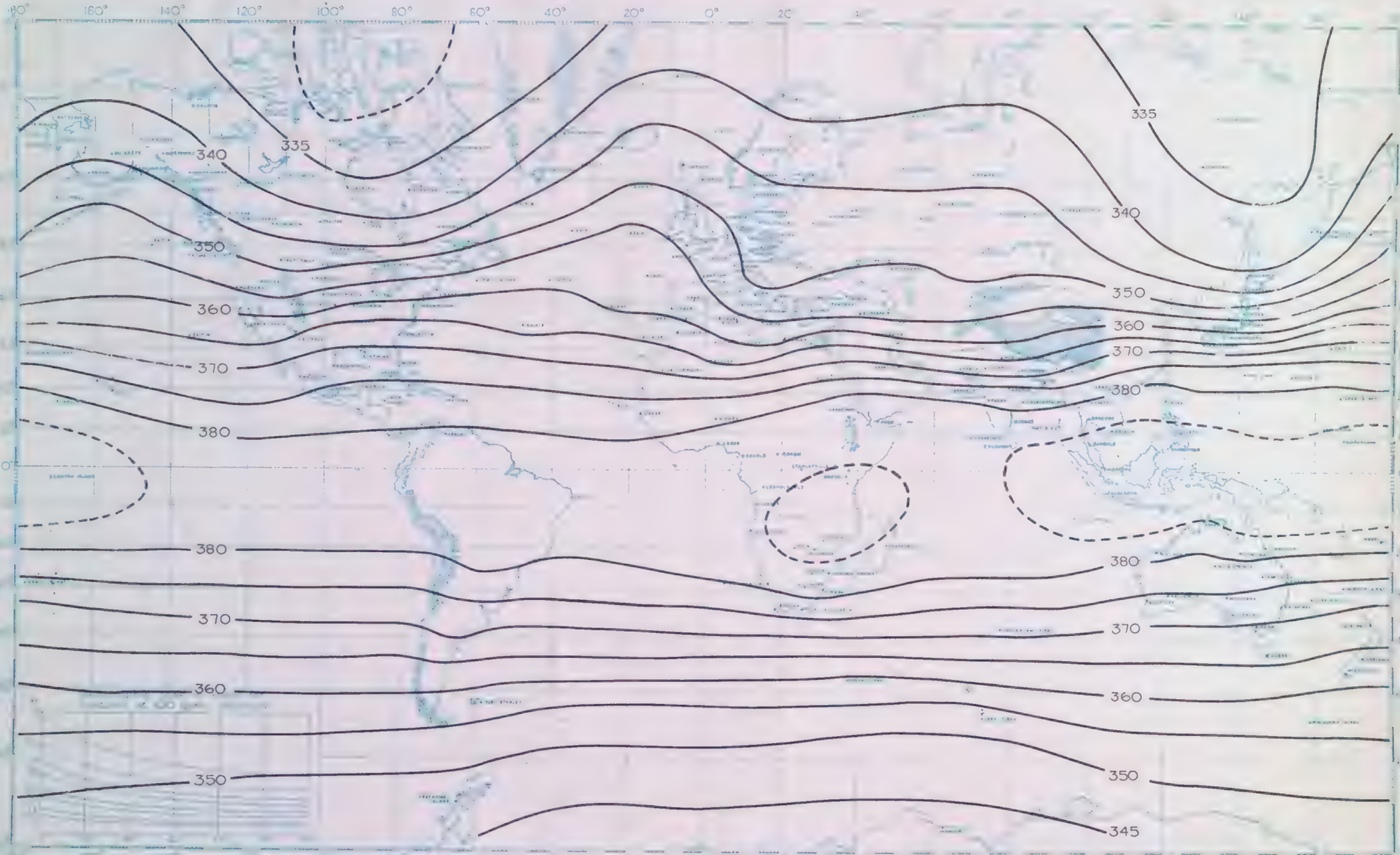
Land over 3,000 metres

Upper Air Branch (M.O. 23)

M.R.P. 1045

Average 500-300 Thickness

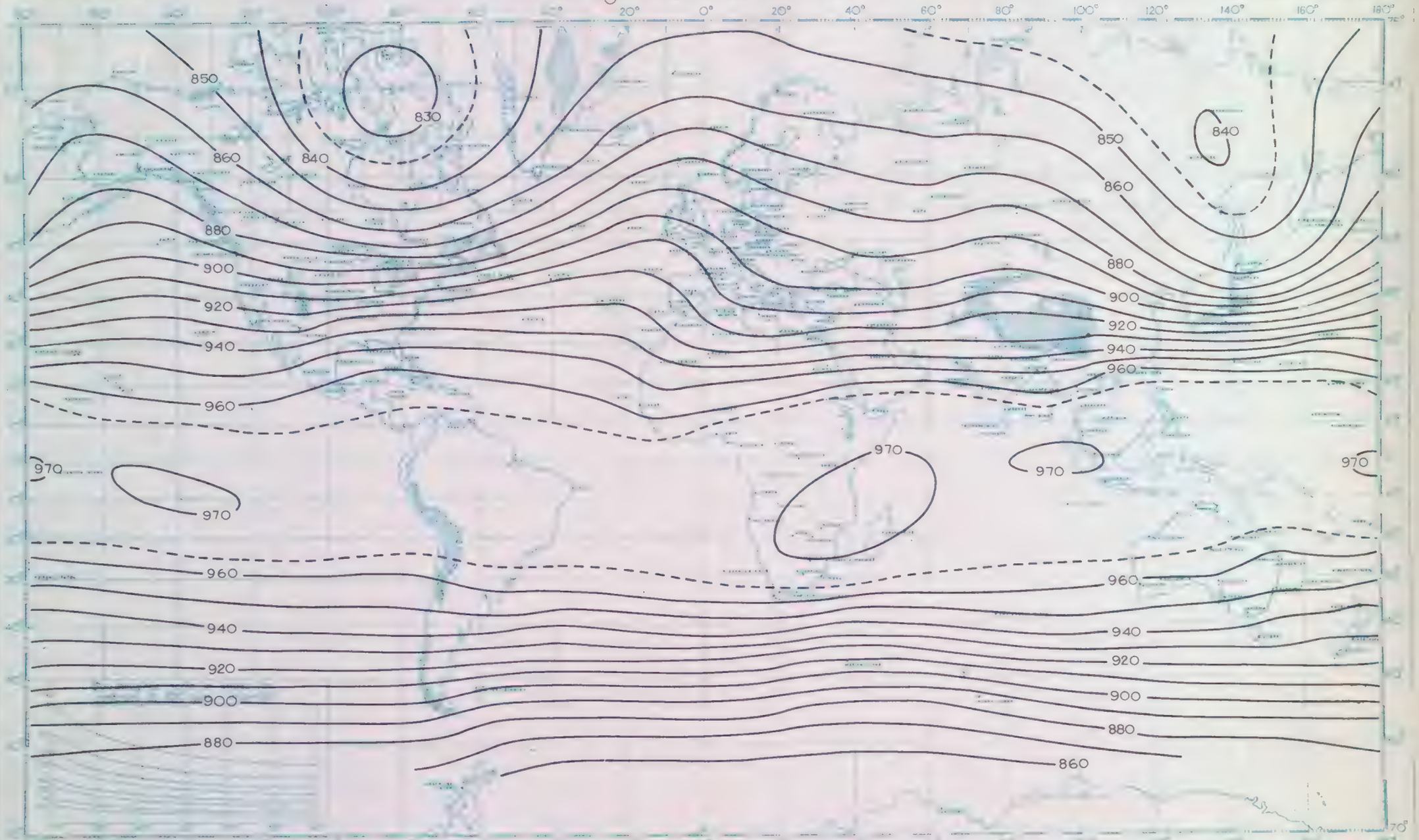
JANUARY 1949-1953



M.R.P. 1045

Average 300 mb Contours

JANUARY 1949-1953



M.R.P. 1045

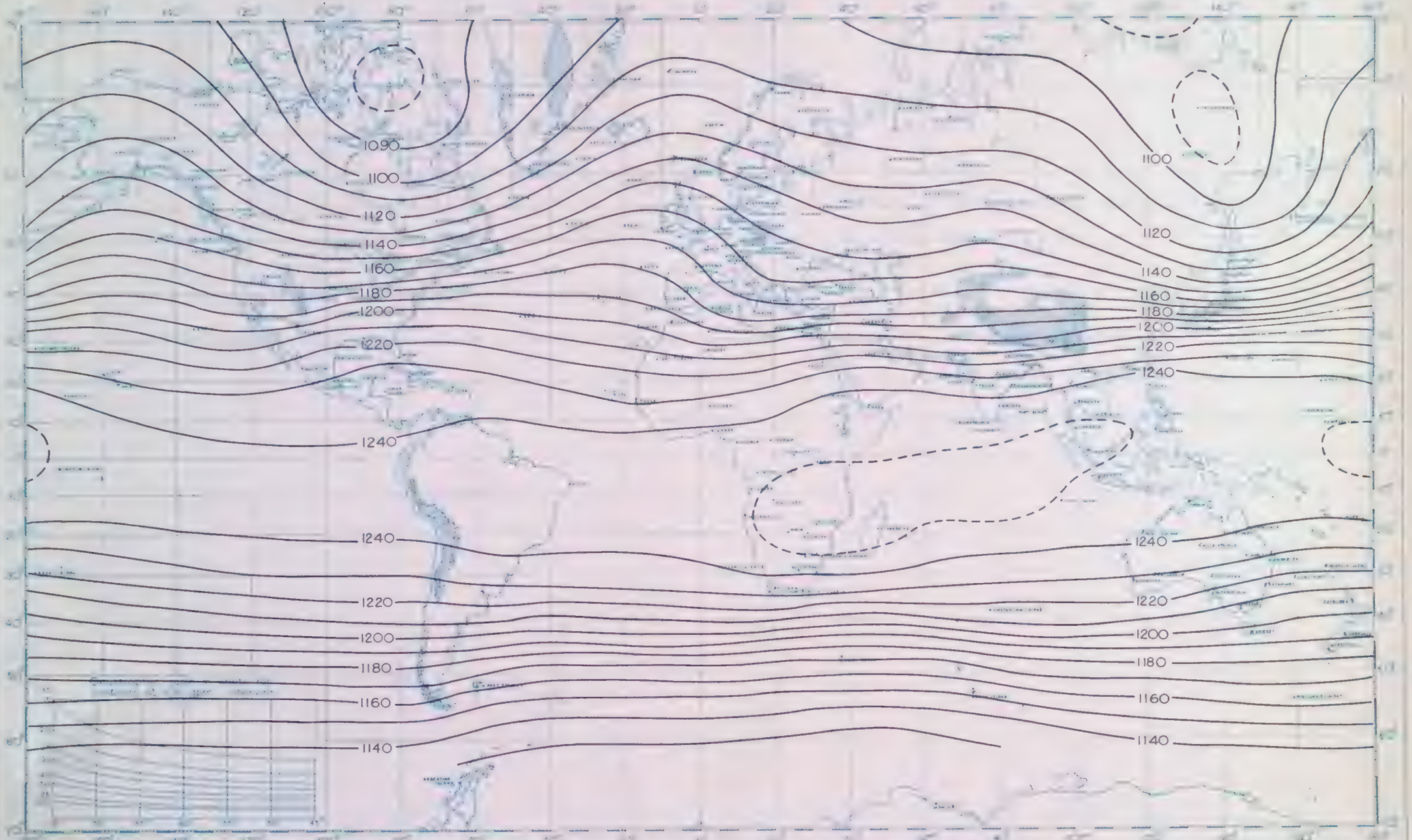
Average 300-200 mb. Thickness

JANUARY 1949-1953

M.R.P.1045

Average 200 mb. Contours

JANUARY 1949-1953



Temperature in °C.

Height in decametres

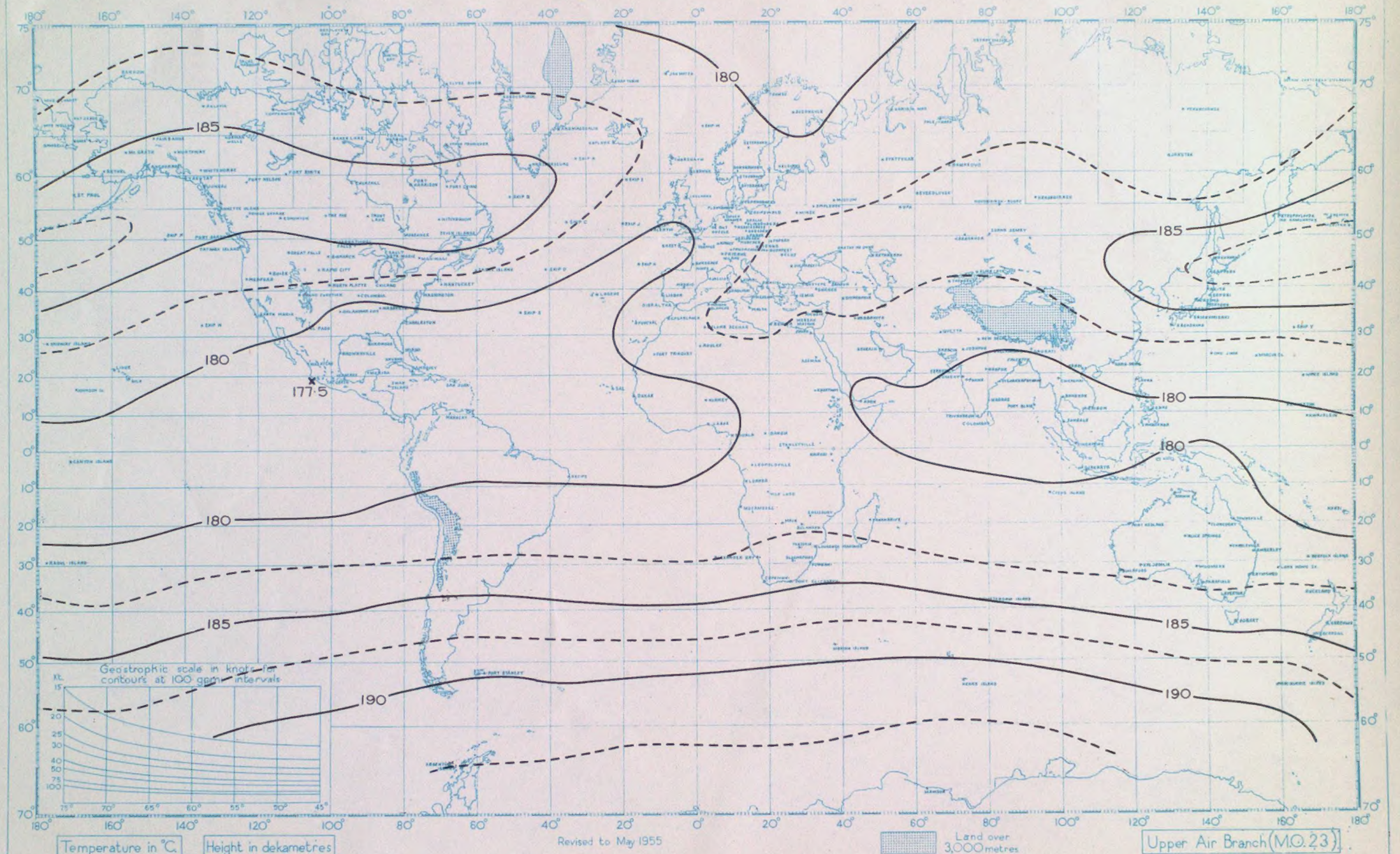
Revised to May 1955

Upper Air Branch (W.B.) 4

M.R.P. 1045

Average 200-150 mb. Thickness

JANUARY 1949-1953



Temperature in °C.

Height in dekametres

Revised to May 1955

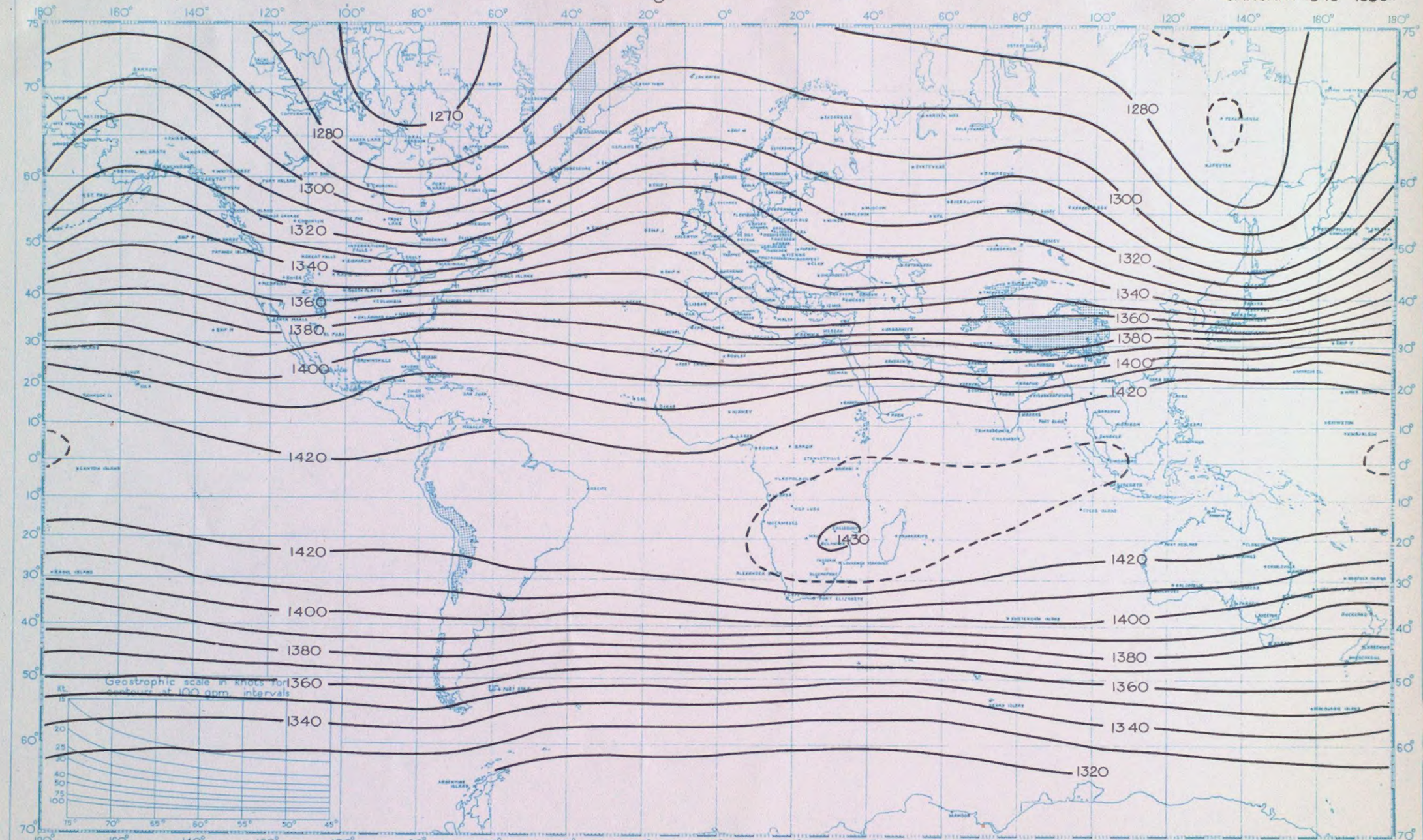
Land over 3,000 metres

Upper Air Branch (M.O. 23).

M.R.P. 1045

Average 150 mb. Contours

JANUARY 1949 - 1953



Temperature in °C.

Height in dekametres

Revised to May 1955

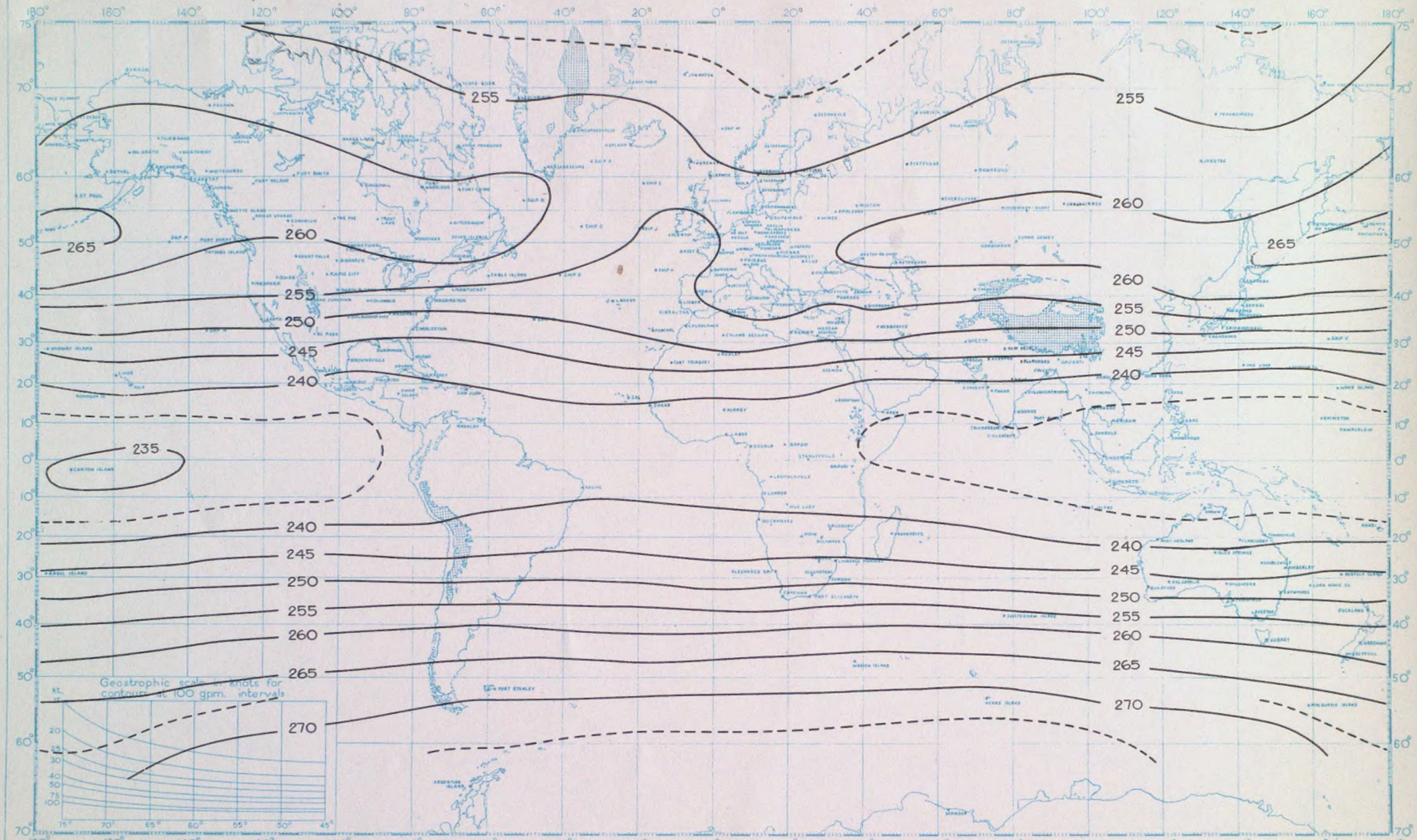
Land over 3,000 metres

Upper Air Branch (M.O. 23)

M.R.P. 1045

Average 150-100 mb. Thickness

JANUARY 1949-1953



Temperature in °C.

Height in dekametres

Revised to May 1955

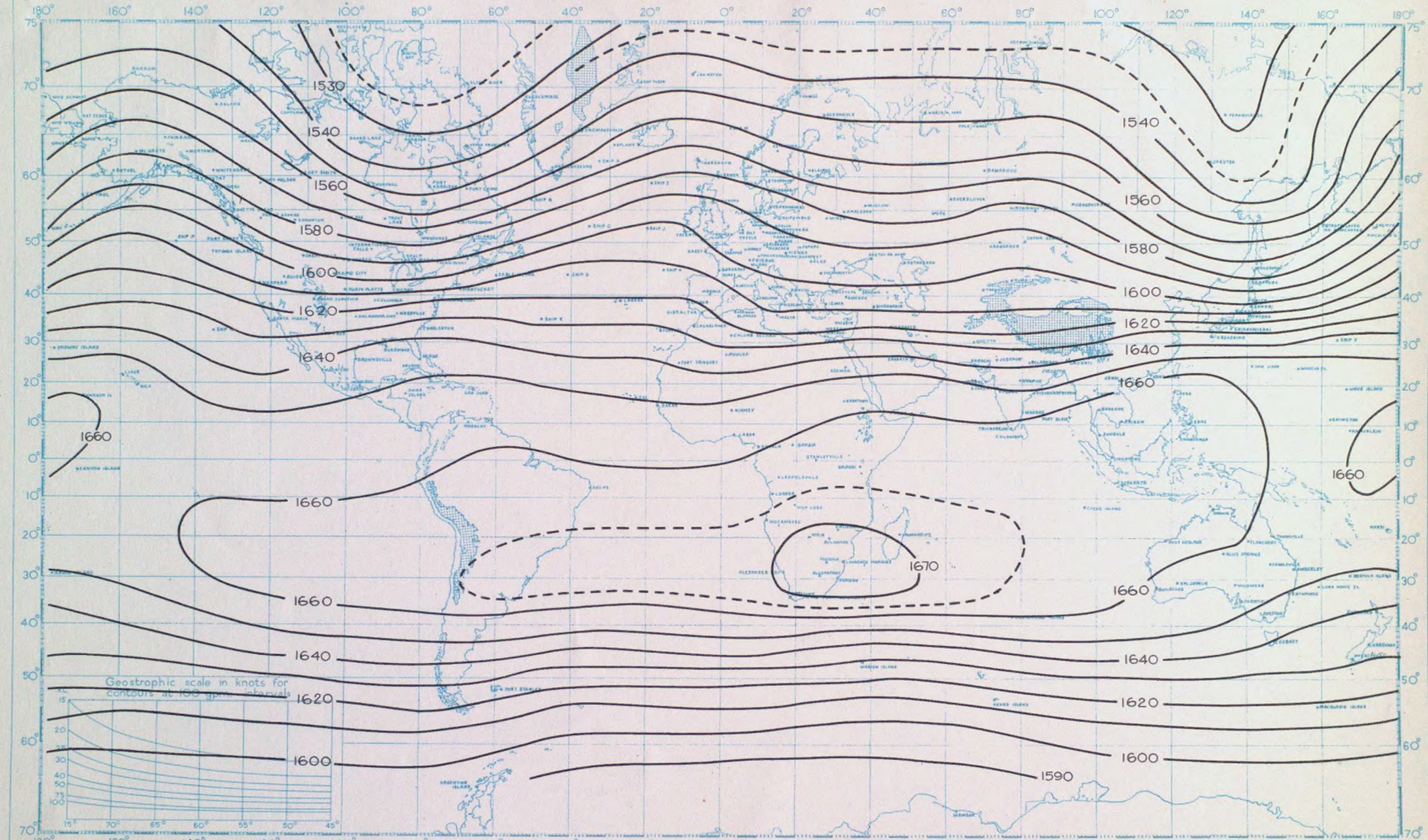
Land over 3,000 metres

Upper Air Branch (M.O. 23)

M.R.P. 1045

Average 100 mb. Contours

JANUARY 1949-1953



Temperature in °C.

Height in dekametres

Revised to May 1955

Land over 3,000 metres

Upper Air Branch (M.O. 23)